Unit 2

Part 2

Matter Exchange & Transfer

AP Biology

Mrs. Petrov

What is matter?

How is it different from energy?

What are the forms of matter needed by…

Autotrophs?

Heterotrophs?

98% of the Atoms in Organisms…

- Sulfur
- Phosphorous
- Oxygen
- Nitrogen
- Carbon
- Hydrogen

- SPONCH

Major Compounds

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids

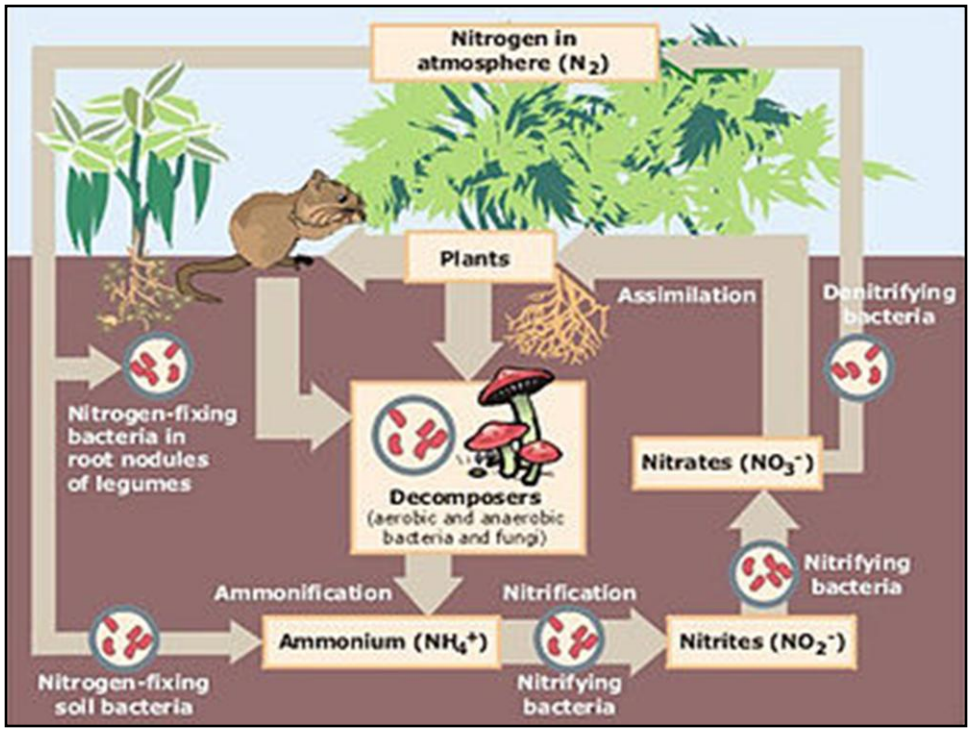
Identify the atoms found in each of the compounds above

Carbohydrates:

Lipids:

Proteins:

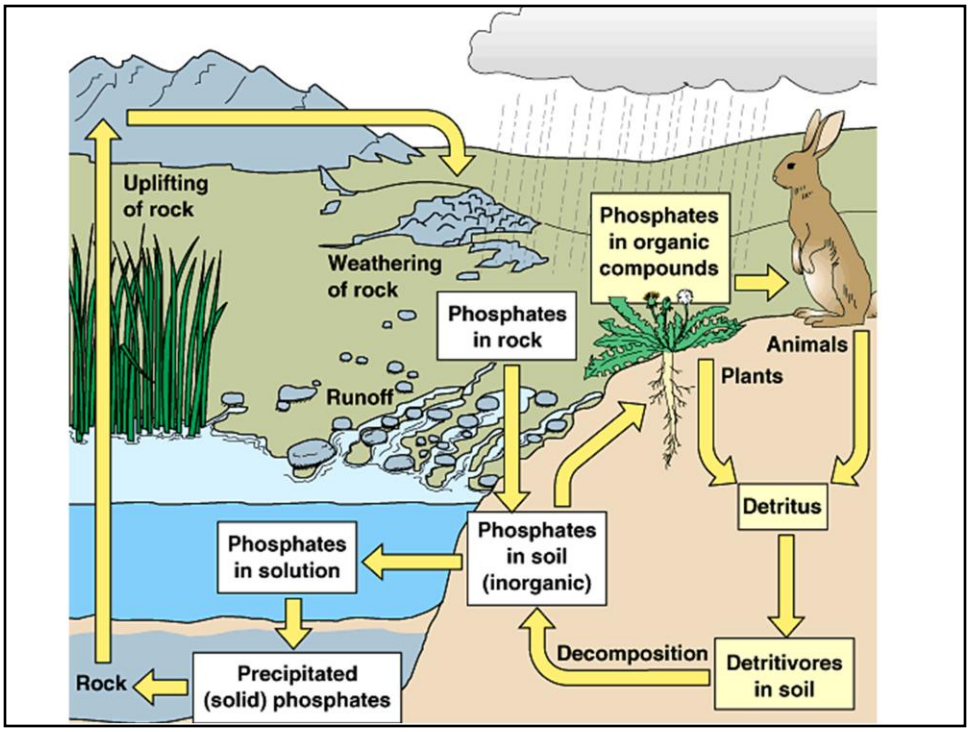
Nucleic Acids:



Nitrogen

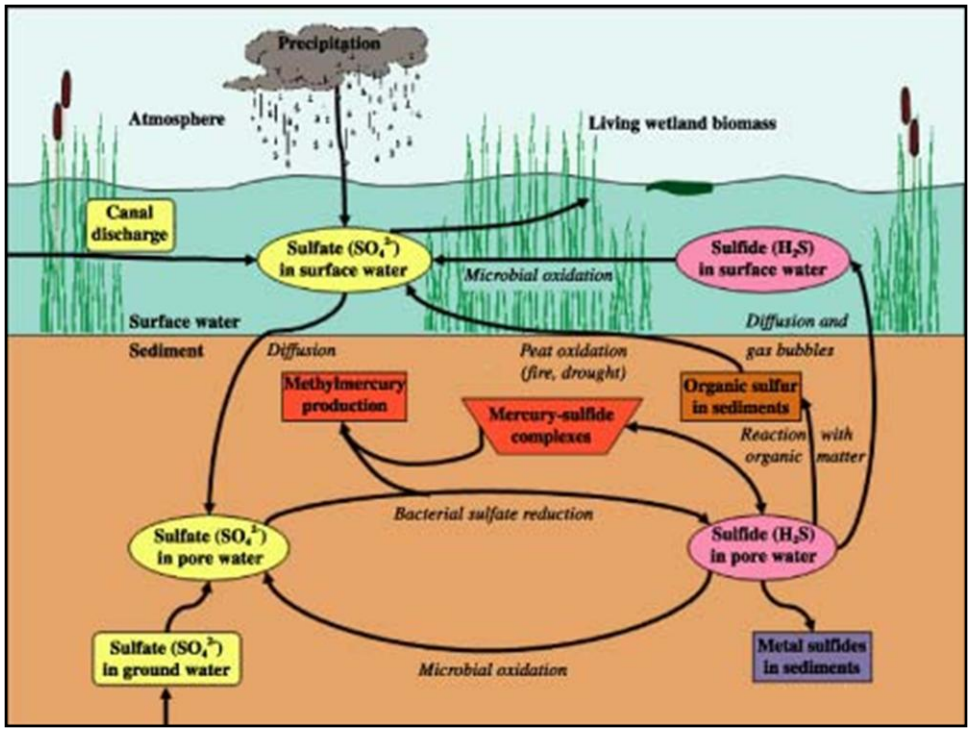
Nitrogen w/ hydrogen = ammonia
Alternate medium for life???
Not likely but not impossible on other planets!
Moves from the environment to organisms; used in proteins & nucleic acids (DNA/RNA).

Bacteria are key to nitrogen recycling. Explain why.



Phosphorous

Used in Nucleic Acids, Membrane Lipids & Many cellular intermediates (ADP→ ATP)

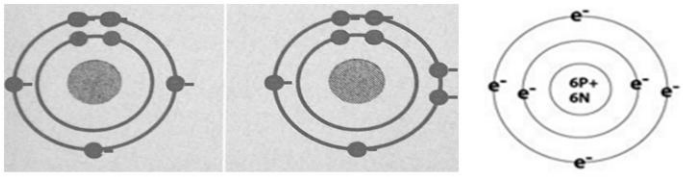


Sulfur Cycle
Used in Proteins - forms strong covalent bonds between amino acids.

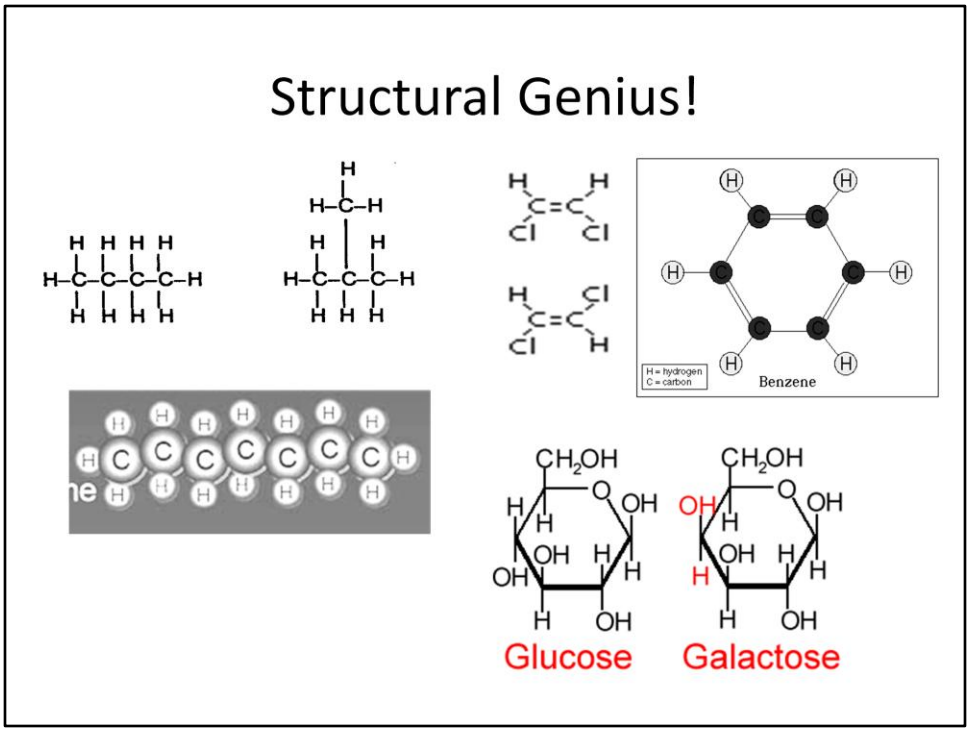
Carbon

- Used in storage compounds and cell formation in ALL organisms.
- Why is carbon so special?
- ***Tetra***valence: Forms 4 covalent bonds

Nitrogen Oxygen Carbon



How many bonds can Nitrogen form? Oxygen?



Linear molecules

Branched molecules

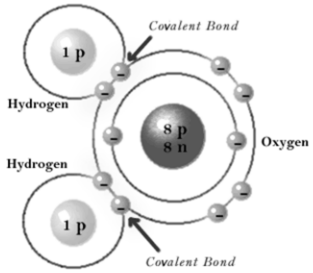
Rings

All the different structures make possible the phenomenon of molecular specificity

- Receptors
- Enzymes

Water

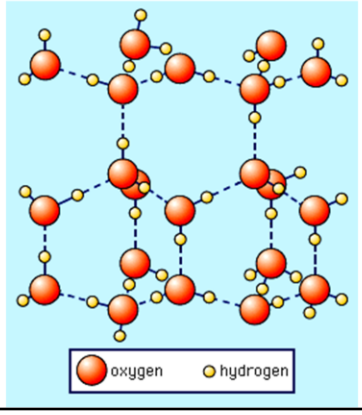
- 1 Oxygen atom bound to 2 Hydrogen atoms
- Oxygen is electronegative – shifts electrons towards itself easily!
- Results in 2 polar covalent bonds



Explain why water is a polar molecule

Water

- Makes water “sticky”
- Other polar molecules form sticky bonds = **Hydrogen Bonding**



Have you ever tried to put on clothes when you’re still wet from a shower?

Water adheres to surfaces and also sticks to itself…making the clothes feel like they are ‘dragging’ as you put them on.

Water

- As a result of polarity & hydrogen bonding, water is…
  - Able to dissolve almost any compound
    - Universal Solvent supporting reactions
  - Difficult to change from one phase to another
    - Allows for a large quantity of heat to be absorbed/released before “boiling” or “freezing”

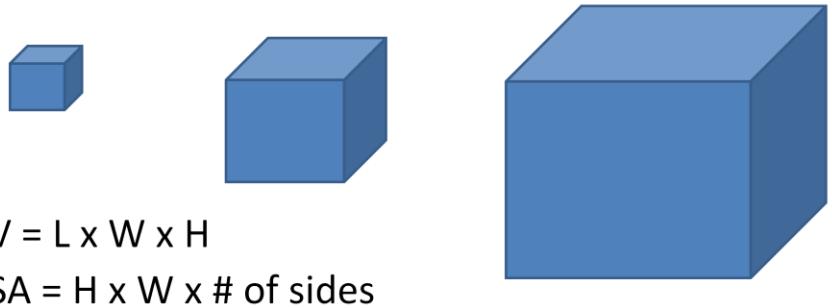
Most organisms living in marine environments have changed very little throughout geologic history.

Rationalize this by discussing the properties of water.

Exchanges with Environment

- Cells are the basic unit of exchange, even in large multicellular organisms.
- Why not be just 1 enormous cell???
- Issue of surface area – volume ratios
- As cells increase in size, the volume increases faster than the membrane's surface area.
- More demand for exchange, not enough area to make the exchanges!

SA to Volume Ratios



V = L x W x H

SA = H x W x # of sides

SA / V = Ratio

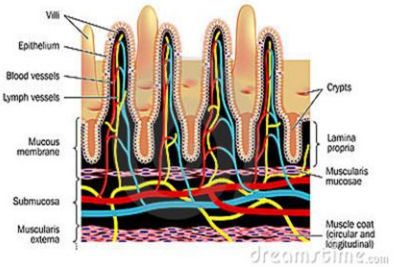
Smaller cells more favorable!

Which is more efficient?

Low SA/V ratio or High SA/V ratio. Justify your response with data.

Adaptations for Increasing SA Without Significantly Increasing V

- Intestines: Specialize in absorption of materials = **microvilli**
- Lungs: Specialize in gas exchange = **alveoli**
- Roots: Specialize in absorption of water = **root hairs**



The Amoeba is a rather large **heterotrophic unicellular** protozoan, capable of shifting it's body form into many shapes due to its lacking a cell wall.

Draw the most suitable body form for an amoeba that is actively exchanging materials with its environment, and justify your drawing with a written explanation. In addition, include ***what types of materials*** it would need to exchange during its metabolism!

Membranes

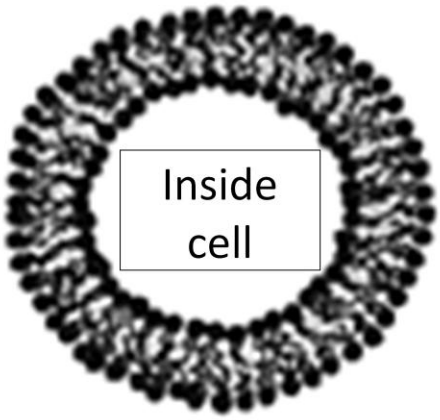
- What defines a cell?
  - Nucleic Acid, usually DNA
  - Cytoplasm
  - Ribosomes
  - **MEMBRANES** to contain it all!

Membrane Evolution

- In order for cells to have evolved, molecules must have aggregated together to form a barrier…how & why would this happen???
  - Remember the Coacervate Lab

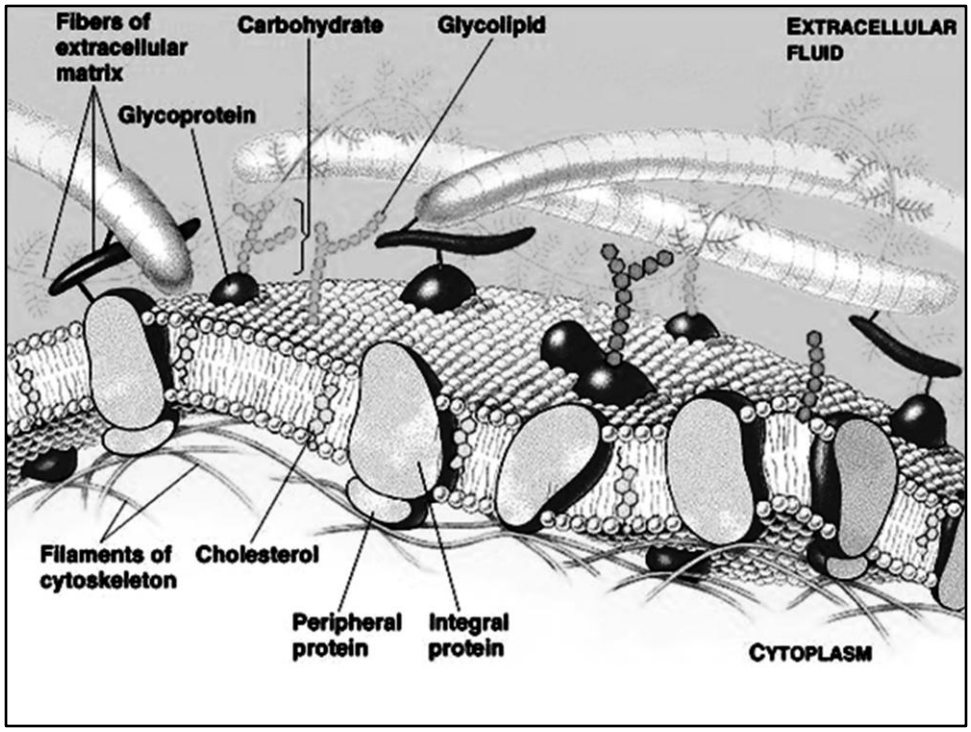
Membrane Structure

- 2 Layers of **Phospholipids**
- "heads" = hydrophillic
  - Phosphates are polar like water
- "tails" = hydrophobic
  - Fatty acids are non-polar (like oil)



Membrane Structure

- More to the story…
- Membranes also have a variety of molecules embedded within or sticking out of them.
- Called the “Fluid-Mosaic Model”
  - Fluid = The Bilayer of Phospholipids
  - Mosaic = The stuff stuck in the membrane



Provide the general functions for the structures associated with the membrane.

Glycoproteins & Glycolipids

Integral Proteins

Peripheral Proteins

Cholesterol (animals only)

Cell Walls

- Plants have cell walls external to the membrane. Made of a carbohydrate called cellulose.
- Prokaryotes, Fungi & many protozoa have cell walls too.
- All serve as structural boundaries and permeability barriers for some substances.

Which group of organisms does not have a cell wall?

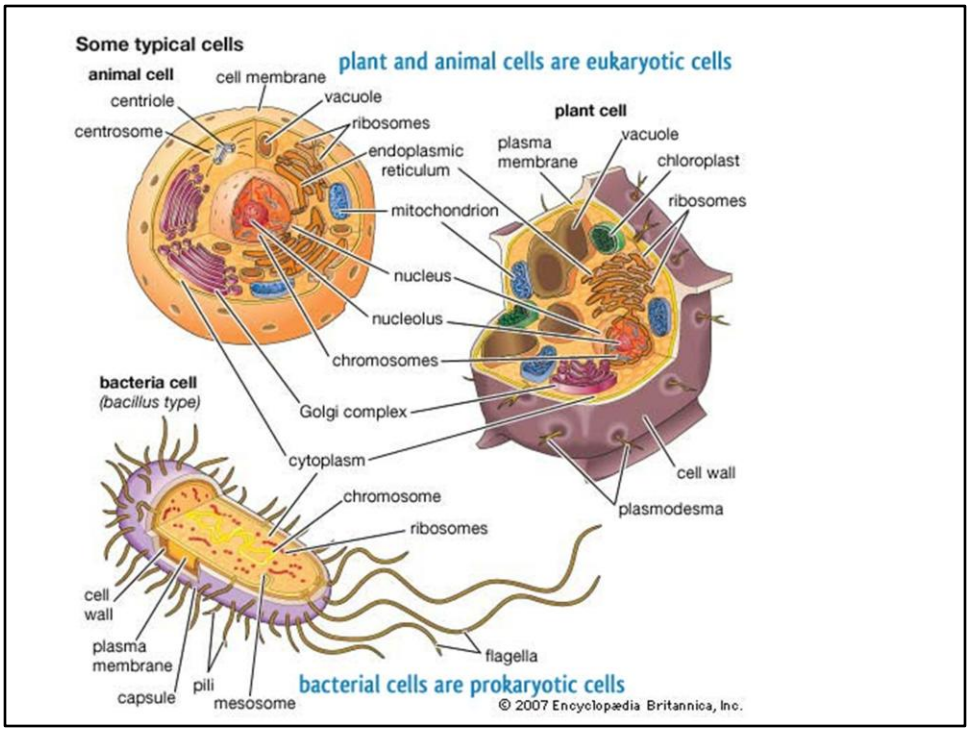
Why do you think that is?

Eukaryotes vs. Prokaryotes

- ***Internal*** membranes facilitate cell processes by minimizing competing interactions and by increasing surface area where reactions can occur
- Prokaryotes (such as???) LACK these internal membranes, meaning no organelles!
- Organelles compartmentalize internal processes and specific enzymatic reactions.

What are some specific internal membranes you have learned about so far?

Justify the claim presented in the 1st point above using the 2 metabolic processes you learned. For the "competing interactions", think about the molecules ATP & glucose as examples. These are used in many different chemical reactions, therefore all the reactions that can use them, are "fighting" over it.


Some typical cells
plant and animal cells are eukaryotic cells
animal cell
cell membrane
centriole
vacuole
centrosome
ribosomes
endoplasmic reticulum
mitochondrion
nucleus
nucleolus
chromosomes
Golgi complex
cytoplasm
plant cell
plasma membrane
vacuole
chloroplast
ribosomes
cell wall
plasmodesma
bacteria cell
(bacillus type)
chromosome
ribosomes
cell wall
plasma membrane
capsule
pili
mesosome
flagella
bacterial cells are prokaryotic cells
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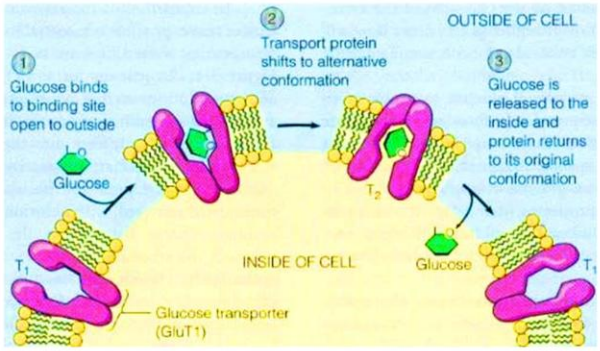
Transport Through Membranes

- What CAN move freely through membranes?
  - Small nonpolar molecules
    - N_2, CO_2, O_2
  - Small, uncharged polar molecules
  - Water: KIND OF…passes through special channels called **aquaporins**.
  - Travel via PASSIVE TRANSPORT, no free energy required. Ex. Diffusion, Facilitated diffusion

Passive Transport

- Primary role in the import of resources & export of wastes
- Membrane proteins play a role in **facilitated** diffusion of charged & polar molecules

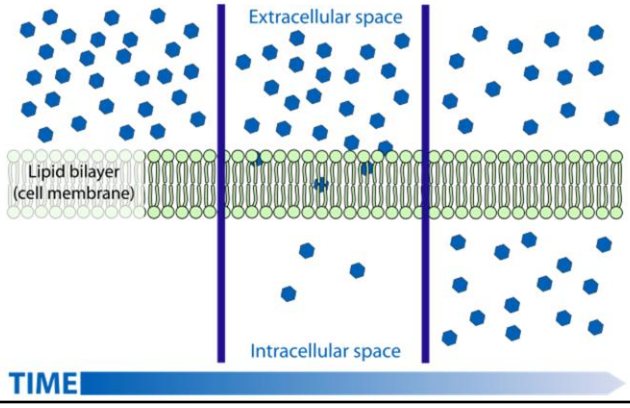


Explain the mechanism of facilitated diffusion.

How is it different from /similar to simple diffusion?

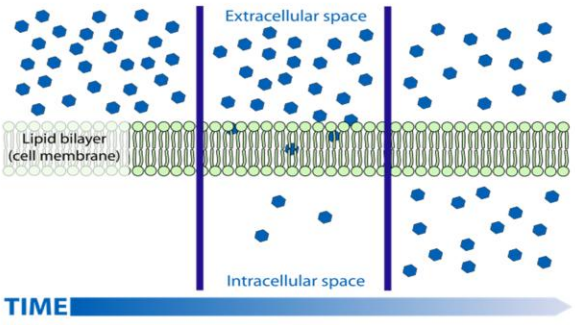
Passive Transport

- Movement of molecules follows a gradient from areas of high concentration to areas of low concentration.



Passive Transport

Hypertonic Isotonic



Hypotonic Isotonic

Explain the terms above using the diagram.

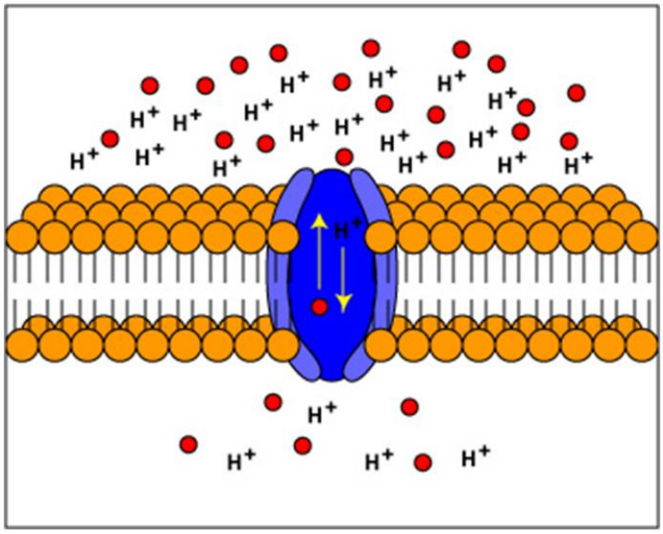
Transport Through Membranes

- What CAN'T move freely through membranes?
  - Large polar molecules (ex. Sugars)
  - Ions (ex. Na^+ Cl^- H^+)
  - Travel via ACTIVE TRANSPORT
    - Proton pumps (photosynthesis, cell respiration!)
    - Protein gated channels

Active Transport

- Requires free energy to move molecules from areas of low concentration to areas of high concentration
- ATP is used by proteins embedded in the membrane to “move” molecules/ions across the membrane to establish and/or maintain concentration gradients

Active Transport

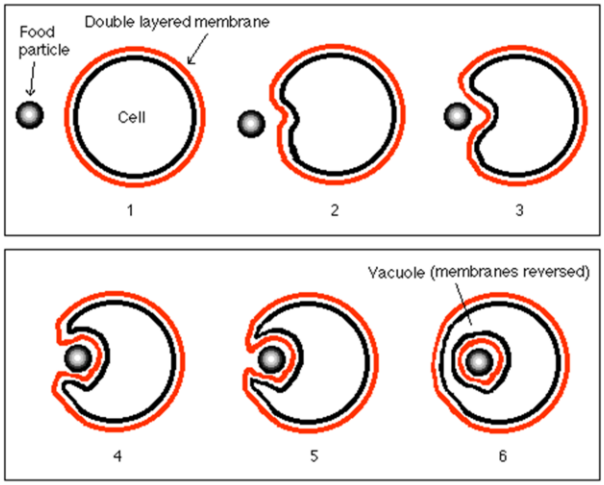


Active Transport

- Movement of large molecules require either exocytosis or endocytosis
- Endocytocis brings materials into cells
- Exocytosis exports materials from cells

Active Transport

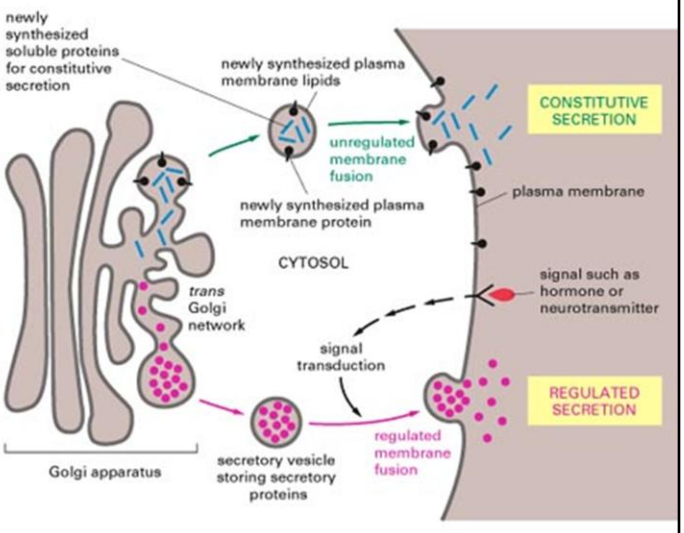
- Endocytocis



Explain the steps…

Active Transport

Exocytosis



Explain the steps…